

## THE SURGICAL TREATMENT OF INTRASPINAL TUMORS.<sup>1</sup>

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AMONG the many fields of surgical activity which owe their present advanced state largely to the labors of physicians, few have owed so much in the past or still owe so much to them as that of spinal tumors, although to a surgeon—von Leyden (1874)—is due the first suggestion of an operation for the amelioration of the symptoms produced by this disease. Nor, I think, would any surgeon presume at the present day to perform laminectomy for a suspected intraspinal growth without consulting a neurological colleague, even were the surgeon himself capable of diagnosing and of accurately localizing the tumor. It is therefore not the purpose of the present paper to treat at length of the symptoms and diagnosis of these affections; it is quite sufficient to recall briefly the salient features which would in the case of any patient suggest to the surgeon a neurological consultation.

Pain is usually the symptom first complained of, and is generally of a rheumatic or neuralgic character, localized to one limb, or to certain of the intercostal nerves. It is frequently more or less completely relieved temporarily, but persistently returns, and constantly grows more severe. To the pain is next added—often, however, not for some years—a numbness and heaviness in one or more of the limbs. The symptoms are almost invariably unilateral at first, but with equal constancy become bilateral before paresis has fully developed. Girdle sensation, with a zone of hyperæsthesia immediately above the limit of the anæsthetic area, is also usually

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observed. Early in the course of the disease the affected limbs are spastic, but later the reflexes are lost, and in time the muscles lose their reaction to the Faradic and to the galvanic current as well. The loss of certain of the sensations, as those of heat and cold, while others are retained, considered characteristic of syringomyelia, is also sometimes observed in tumors pressing on the spinal cord; and several instances are known where operations, undertaken for the removal of supposed spinal tumors, have relieved, at least temporarily, the syringomyelic symptoms by the evacuation of the cystic collections found in this disease. Local physical symptoms of a tumor are usually absent, such symptoms, for example, as deformity and rigidity of the spinal column, or tenderness on pressure over the site of the tumor; but when such symptoms are present, they are of course a considerable aid in diagnosis, when tuberculous caries of the spine can be excluded.

The science of spinal localization is now so well developed that it usually is not difficult to determine with accuracy the location of an intraspinal growth; and since multiple growths are exceedingly rare, the chances for successful removal of a spinal tumor would be overwhelmingly favorable did success depend upon localization alone. But besides this factor we must also consider the inherent difficulties of the operation, the nature of the tumor, and its relation to the membranes of the cord.

In searching the literature for reports of operations for tumors of the spinal cord, a number of cases have been found which do not strictly come under this classification. What is usually understood by the term tumor of the spinal cord is an extramedullary but intraspinal growth like a sarcoma, a fibroma, or a myxoma, giving no evidence of its existence except by the symptoms of medullary pressure which it produces. Thus, tumors of the spinal column—osteomata, enchondromata, or sarcomata, which are palpable externally, and are readily diagnosed by an ordinary physical examination—should not be included unless by extension into the vertebral canal they produce medullary symptoms. Cases of pressure

on the cord due to traumatism or to tuberculous caries of the spine are also of course excluded. But I have included in my tables certain cases in which, although there were present external symptoms of the growth, there was nevertheless no direct connection between the two. For instance, a case reported by Curtis, in which laminectomy was done for spinal involvement secondary to carcinoma of the breast, has been included, although such extension of malignant growths is not very unusual,\* and such cases do not strictly belong to the class of intraspinal tumors. No cases have been included, however, in which laminectomy was a mere incident in the removal of a growth extending into the spinal canal, but in which it was an operation not intentionally undertaken to relieve the symptoms of spinal irritation.

There have been found records of 92 operations for spinal tumors, among which number 43 patients died,—a total mortality of nearly 47 per cent. McCosh has stated (*Journal of the American Medical Association*, 1901, ii, 621) that the mortality of laminectomy *per se* should not be more than 10 per cent.; and if from the percentage above given we omit those cases, 17 in number, ultimately known to be fatal, but in which death ensued some weeks or months after the operation, we can reduce our mortality to 26 cases, or 28 per cent. Even with a mortality of nearly 30 per cent., it does not seem to me that the surgeon should hesitate to operate in these cases, since, even when a cure cannot be obtained, relief from the pain is almost invariably secured, and the patient in most instances lives as long as he would have done if no operation had been performed.

The nature of the tumor is recorded in 88 of the reported cases. It was sarcomatous in two-fifths of the whole number (37 cases); † adhesions, thickenings, etc., hold second place,

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\* C. N. Dowd (New York Medical Record, 1898, i, 347) collected histories of twenty-nine cases of mammary carcinoma, in five of which there had been distinct symptoms of involvement of the spine.

† Of Schlesinger's 400 cases of spinal tumors, one-quarter was sarcomatous.

with 11 cases; then comes echinococcus, 8 cases; fibroma, 6 cases; syringomyelia, 5 cases; endothelioma, 4; psammoma, 3; cyst, 3; fibromyxoma, 2; osteoma, 2; and one each of myeloma, lipoma, lymphangioma, dermoid cyst, primary and secondary carcinoma, and one tumor of bone whose nature is not stated. In only three instances where the patient recovered from the operation did no improvement follow it. Two of these were cases of inoperable sarcoma, and the third was a case of syringomyelia. The annexed table shows that of those patients, 49 in number, who survived the operation for some weeks or months, no less than 29, or 59 per cent., recovered their functions sufficiently to be classed as cured; that 17, or 34 per cent., could be classed as improved by the operation; while in the condition of only three patients, or 6 per cent., as mentioned above, did the operation effect no change.

Variety of Growth.	Total.	Died.	Recovered.		
			Cured.	Im- proved.	Not Im- proved.
Sarcoma .....	37	20	8	7	2
Adhesions, etc. ....	11	5	4	2	0
Echinococcus .....	8	3	5	0	0
Fibroma .....	6	2	3	1	0
Syringomyelia .....	5	2	0	2	1
Endothelioma .....	4	2	1	1	0
Psammoma .....	3	1	1	1	0
Cyst .....	3	0	2	1	0
Fibromyxoma .....	2	1	1	0	0
Osteoma .....	2	0	2	0	0
Tumor of vertebra ....	1	1	0	0	0
Myeloma .....	1	0	0	1	0
Lipoma .....	1	1	0	0	0
Lymphangioma .....	1	0	1	0	0
Primary carcinoma ....	1	1	0	0	0
Secondary carcinoma ...	1	1	0	0	0
Dermoid cyst .....	1	1	0	0	0
Not stated .....	4	2	1	1	0
	92	43	29	17	3
			49 Recovered.		

In discussing the sarcomata recorded here, it may seem audacious in the extreme for a surgeon to mention such a thing, but it does not seem impossible to me that in some

instances the microscopical diagnosis may be in error. It certainly appears from this table, where 17 out of 37 sarcomatous patients are reported as having recovered from the operation, that sarcomata of the spinal canal do not possess that extreme malignancy which characterizes them in other parts of the body. When three such patients are reported as in fair health at a period of more than six months after the operation, and five are said to be well at the end of from two and a half to five years after the operation (of which latter cases two patients, surviving more than four and five years respectively, had intradural sarcoma), it makes one very sceptical as to the reliability of histological diagnoses. Some of these cases are reported as having an infiltrating sarcomatosis, practically inoperable; yet, after cautious curettement of the external surface of the diseased dura, no recurrence is noted even when years have elapsed. Cushing's case is reported frankly enough as one in which reasonable doubt existed as to the diagnosis between fibrosarcoma and fibroma; and McCosh likewise states that, in view of the subsequent history of his patient (no recurrence after two and a half years), it is probable that the tissue removed at operation was granulation tissue and not sarcomatous in character. But other observers, especially the German surgeons, do not seem to have been struck by this point. We all know with what melancholy regularity sarcoma recurs in amputated stumps and in extirpated glands; but when it occurs along a man's spinal marrow, it seems that we may expect its removal to insure against recurrence in nearly or quite half of the cases.

I have included in the table twelve operations where symptoms of spinal tumor were produced by meningeal thickenings or adhesions. In at least five of these cases (Macewen's) the patients had suffered from Pott's disease of the spine in previous years, and a kyphosis still remained; but no tuberculous process was found at the operation, and with Starr's tables (*American Journal of the Medical Sciences*, 1895, ciii, 613) of spinal tumors as my authority, I have thought it proper to include them with tumors rather than among cases

of laminectomy for spinal caries. I have myself recently done the operation of laminectomy on a patient with old Pott's disease, in whom no active bone disease was found, but in whom the paralysis appeared to be due to extradural thickening, and not to actual compression from the angulation of the spine.

CASE I.—*Paraplegia from Pott's Disease; Laminectomy; Great Improvement.*—Harry S., aged twenty-six years, was admitted to the Orthopædic Hospital, Philadelphia, September 5, 1904. There was no tuberculous family history obtainable. The patient had had pneumonia at two years, scarlet fever at five years, and diphtheria at seven years of age. In 1896, when nineteen years old, he had typhoid fever, which was complicated by phlebitis in both lower extremities, the right being the first affected. After about three months of convalescence his legs ceased to swell. In 1898 he entered the army, and fell and struck his left knee-cap. The injury was not severe, but there was much swelling and a good deal of pain. For this condition he was admitted to the Pennsylvania Hospital, June 29, 1898, under the care of the late Professor Ashhurst. The diagnosis was tuberculous arthritis of the left knee. In July some iodoform emulsion was injected into the joint. In August an abscess, apparently tuberculous in character, formed on the inner middle aspect of his right arm. This was opened and drained. In September, 1898, the patient was discharged from the Pennsylvania Hospital, walking with crutches. Six months later, in May, 1899, he returned to the Pennsylvania Hospital for examination, and was under my care. His limb was in good condition, and he had a fairly useful knee. He was allowed the use of his leg. After this date he states that the abscess on his arm opened again, and that his shoulder became stiff. In 1901 he was again admitted to the Pennsylvania Hospital, and the knee-joint was found so badly diseased that it was thought impossible to further pursue conservative treatment. Dr. Barton Hopkins accordingly amputated the left thigh in its lower third. The patient made a good recovery from the operation, and returned to his home in Harrisburg. Not long after this date he noticed a hump the size of a hickory-nut in the lower dorsal region of his spine. He complained chiefly of pains in the lumbar region, and was treated for lumbago. He was not seriously incommoded, how-

ever, until June, 1904, when he suffered from what he describes as remittent fever, being confined to bed for two weeks. When he got out of bed, he noticed that a numbness which he had felt for some months around his hips had increased, and also that his foot was numb. He very soon lost the use of his body and limbs below the waist-line.

On admission to the Orthopædic Hospital, in the autumn of 1904, he was paralyzed from the waist down, and sensation was markedly impaired throughout the affected area. He had retention of urine and a severe grade of cystitis. The stump of his amputated left thigh was in good condition. There was very marked kyphosis in the lower dorsal region. Extension was applied to his head and right leg, and measures were adopted to relieve the cystitis. Sensation improved somewhat, the cystitis was finally cured, and the patient regained control of his bowels and bladder. He also became able to flex the great toe occasionally, and by contracting his abdominal and psoas muscles he could barely move both thighs. He remained in this state for many months, and, as no further improvement seemed probable, the question of laminectomy arose. He was examined by one of the neurological staff, who advised against any operation. Nevertheless, on April 27, 1905, nearly eight months after his admission, laminectomy was undertaken, the patient being willing to undergo any operation that offered him even the remotest chance of improvement. A cure was not anticipated. The spines and laminae of the ninth, tenth, and eleventh dorsal vertebrae were removed, and some extradural thickening dissected out. Practically no shock attended the operation, and on recovery from the anæsthetic the patient expressed himself as being able to feel the bed under him in a much more real way than he had done before. He said he no longer felt dead below the waist. Gradually increasing power in the great toe developed, and at the end of four weeks sensation was perfect all over the lower extremities, all the toes could be freely moved, the ankle-joint could be flexed and extended at will, the knee and thigh could be raised from the bed, and the amputated thigh could likewise be moved. Before the operation, when one or two movements of the great toe had been made, all power was exhausted, and no further motions could be made for some hours. Now he can move his muscles at will all day long.

With very few exceptions, it is impossible to determine the nature of the tumor before operation. Gummata may nearly always be excluded; they are very rare in the spinal canal, and it is never worth while to delay operation for the sake of trying antisyphilitic treatment. According to Starr (*Journal of the American Medical Association*, 1901, i, 202), only twenty-six gummata were found in a series of 400 cases of tumor of the spinal cord. Sarcoma can only be diagnosed with certainty when the spinal lesion is clearly secondary to similar disease elsewhere in the body. The only other tumors found which are frequently secondary in origin are hydatid cysts. Among the eight recorded operations for this condition, three were palpable over the spinal column, and one of these (Trendelenburg's) was reoperated after four months for recurrence.

In a case recorded by Hale White (*Transactions of Clinical Society of London*, 1900, xxxiii, 140), Fripp operated twice on a young man with spinal pressure from a dermoid cyst in the upper dorsal region. Although on the first occasion the growth was found to be inoperable, yet so much relief was experienced for a period of two months, that another attempt was made to relieve the patient, but unfortunately without success, as the case terminated fatally in eight and a half hours. This young man had suffered from Hodgkin's disease for a number of years; but it was clear, even before the first operation, that the spinal pressure was unconnected with that condition. In the autumn of 1904 I operated on a case of dermoid cyst of the spine, and, although there were no symptoms of involvement of the spinal cord, I desire to place it on record.

CASE II.—*Dermoid Cyst of the Spinal Canal; Operation; Recovery*.—E. T., a girl, aged seven years, was admitted to the Episcopal Hospital, Philadelphia, August 31, 1904, under the care of Dr. H. C. Deaver. She presented a diffuse swelling over the sacrum, cystic and semifluctuating to the touch, and extending well over to both buttocks. This condition had existed since birth, and had been considered a spina bifida. A few days be-



fore admission she had been struck over the tumor. A small abscess formed, and was opened September 13, 1904, being apparently superficial, and not connected with the spinal tumor. She was discharged from the hospital on September 22; but was readmitted on October 3, coming then under my care, with high fever and evidences of infection of the spinal growth. After appropriate local and general treatment, which caused subsidence of the constitutional symptoms, it was determined to attempt the removal of the spinal tumor, which produced great deformity in the child, as well as interfering with her sitting comfortably on a chair. Accordingly on October 21, 1904, I dissected the cyst out, finding it adherent to the coccyx and the lower sacrum. Part of the coccyx was removed. The wound healed uneventfully though slowly, and the patient was discharged, cured, February 2, 1905. The appearance of the growth at operation was typical of dermoid cyst, and the pathological report confirmed the diagnosis. "The section is undoubtedly tissue from a dermoid tumor in which the connective tissue predominates. There are small areas of epithelial structures, such as serous glandular tissue and extensive areas showing mucosa and submucosa, with solitary follicles and agminated lymph-glands. There are numerous blood-vesels and scattered foci of hæmorrhagic infiltration, considerable fatty tissue, little smooth muscle, but no voluntary muscle." \*

It has usually been stated that extradural tumors were much more frequent and much less fatal than intradural growths. I do not find this to be the case, however. There are 87 cases in which the situation of the tumor with regard to the dura is mentioned; in 50 of these it was extradural, and in 36 intradural,—not such a very striking difference. The death-rate, moreover, in the extradural cases was even higher than that of the intradural tumors, being 50 per cent. for the former and only 47.21 per cent. for the latter. This may perhaps be explained by the fact that sarcomata are more frequently extradural than intradural (of 37 sarcomata 16 were intradural and 21 extradural), and that they are also more apt

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\* In connection with the subject of dermoid cysts of the spine, see an interesting article by Bland Sutton in the *ANNALS OF SURGERY*, 1889, ii, 81.

when intradural to be circumscribed or encapsulated, and thus removable with little damage to the surrounding parts; whereas the extradural sarcomata are frequently infiltrating, and may involve the spinal column and surrounding muscles very extensively. Nevertheless, the danger attendant upon intradural operations must not be ignored, since we find that among these operations, all done with antiseptic or aseptic precautions, no less than six of the intradural terminated fatally from meningial infection, whereas only one of the fatal extradural cases has meningitis recorded as the cause of death.

Malaisé (*Deutsch. Archiv für klin. Med.*, 1904, lxxx, 143) has recently written an elaborate article on the diagnosis between intra- and extramedullary tumors of the spinal cord, but in no case reported to-day was it possible to tell before operation the relation of the growth to the dura, much less the fact whether it was in the substance of the cord or not. In only two of these cases (except, of course, those of syringomyelia) was it found at operation that the medullary substance was involved in the growth. These were Fenger's case of spindle-celled sarcoma and Warren's case of endothelioma. The former terminated fatally on the fourth day from septicæmia, but Dr. Warren's patient was in good health more than one year after the operation.

It is interesting to note that among female patients the mortality of operation has been only 45 per cent., while among the male it is 57 per cent. In searching for an explanation of this marked difference, I have noticed that sarcomata were found one-third oftener in males than in females, and suppose that this fact may have something to do with lessening the mortality among women.

Most of the operations were on adults, nearly one-half being between thirty and fifty years of age. The extremes of life were nine years in a boy and sixty-five years in a woman. Those patients under twenty and over fifty gave the highest percentage of recoveries.

The average duration of symptoms before operation was two years and three months. In 12 patients symptoms had

existed for less than six months, in 11 for one year, in 8 for one year and a half, in 12 for two years, in 11 for three years, in 7 for four years, and in 6 for periods varying from four to eighteen years. The duration of symptoms does not, unfortunately, throw much light upon the nature of the tumor, since I find that the average duration of symptoms in the patients with sarcoma was two and three-quarters years, in those with adhesions two and three-quarters years, in those with echinococcus two and one-half years, and in those with fibroma one and a half years; while in all other forms of growth the average was about two and one-eighth years.

A history of injury is noted in only five cases,—three sarcomata, one each a psammoma and an endothelioma.

Of 82 cases in which the region of the spine affected is given, the upper dorsal region was involved in 33 cases, or over 40 per cent.; the tumor was found in the lower dorsal region in 24 cases, in the lumbosacral region in 14, and in the cervical region in 11 cases. As far as the results are concerned, it appears to be immaterial at what level the growth is found.

The cause of death is given in 28 cases. One-half of these were due to shock and hæmorrhage, or to infection and meningitis, there being 7 fatal cases under each of these categories. Eight patients died from exhaustion, three from recurrence of malignant growths, two from hypostatic pneumonia, and one from bed-sores and sepsis.

As regards the technique of the operation, it is essentially the same as when employed in traumatic cases. The patient lies in the prone position, with a sand pillow or other firm support beneath his shoulders and upper chest, so as to raise the diaphragmatic region somewhat away from the table; this position facilitates the operation by rendering the respiration of the patient less labored, as well as by making the spine more accessible. As has been repeatedly demonstrated at operation and autopsy, the inclination of the surgeon is to search for the growth too low down in the spinal canal. Horsley says it may be expected to be found four inches above the

upper limit of the hyperæsthetic zone. In the cases tabulated in this paper, the growth was not found in five; and in three of these it was proved, either at a second operation or at autopsy, that it could have been easily removed at the first attempt had the exploration of the spinal canal been carried higher. Some surgeons have advocated beginning the laminectomy some distance above the supposed location of the growth and then working downward, thinking that the wound would heal better thus than when the spine was explored from below upward, because by the latter procedure the parts divided have their nerve-supply impaired by the more highly situated lesion. But it seems to me that it is much more in accord with surgical principles to begin our operation where we expect to find the tumor, and to subsequently search the spinal canal higher up, if we fail to find the compressing structure where it is believed to be.

The incision should be made on the tips of the spinous processes, and should be amply large, to expose at least three vertebrae. I have never employed osteoplastic resection of the arches, known in Germany by Urban's name, and do not think it is a good form of operation. Sonnenburg condemns it, and attributes the death of one of his patients from meningitis on the eighteenth day to the presence of the retained bones. Nor do I think the plan advocated by Abbe (*New York Medical Record*, 1890, ii, 85) a commendable procedure. This surgeon makes his incision one-half-inch to the side of the spines, then chips them off just below the interspinous ligament, and turns them back with the soft parts as a flap on the other side of his wound, and then proceeds to do his laminectomy. For my own part, I think it better to cut right down on the spines, and then clear the laminae on each side with the scalpel and periosteal elevator. The bleeding during this process is always free, and can only satisfactorily be controlled by packing. Hæmostatic forceps will not hold in the fibromuscular tissues of the spinal gutters. It is most convenient, therefore, to pack one side temporarily while the other is being cleared, and then to pack the second side and return to complete the clearing of the first. By this means little blood is lost, and by the time the

spines and laminæ are cleared the bleeding will have nearly ceased, without the employment of forcipressure, and without the application of a ligature. I have not found transverse division of the spinal aponeurosis at each end of the incision necessary to facilitate the retraction of the flaps; but it may be employed, if preferred.

In the dorsal region, where the spines overlap each other, the next step is to cut off two or three spines at their base with large Butcher's knife-bladed forceps. It is impossible to insert a forceps between the laminæ until the spines are out of the way. When this is accomplished, it may be possible to bite through the bases of the laminæ, next the pedicles, with large knife-bladed forceps. The blades should be set nearly at right angles with the shaft, the angle being on the edge, as in band-age scissors, not on the flat, as in the ordinary curved scissors. If such forceps are not at hand, or if they cannot be made to bite through the laminæ, I prefer to apply a crown trephine to the base of one of the spinous processes, and thus open the spinal canal. The trephine should be at least a half or three-quarters of an inch in diameter. When the canal has once been entered, the opening may be enlarged with rongeur forceps. I do not think the use of chisel and mallet (a gouge is safer) advisable, as a rule, but have at times found them useful in trimming off the ragged margins left by the rongeur forceps.

Hæmorrhage from the spinal veins may be controlled by gauze packing or by Horsley's wax, which should always be at hand.

The condition of the dura should next be examined. A considerable amount of connective tissue may overlie it, and removal of this alone may be sufficient to relieve all symptoms, if no other cause of compression can be found. The dura should pulsate, and normally bulges somewhat into the wound, occluding the extradural space at the limits of the opening made into the bony canal. It is well to be quite sure that no extradural cause for compression exists before proceeding to open the membranes, since the risks of producing meningitis are thus considerably increased. Horsley's dural separator is, I think, the most convenient instrument to use in exploring the

spinal canal beyond the limits of the wound. Krause (*Deutsch. med. Woch.*, 1903, xxix, Ver.-Beil., 321) uses a thick sound to explore when the tumor is not found immediately beneath the opening in the spinal canal. If nothing can be detected by means of cautious exploration in this manner, the dura may then be opened in the median line. The incision should be made with a scalpel hitherto unused in the operation, and the same precautions to avoid injuring the cord are to be used that we employ when opening the peritoneal cavity to guard against injury of the intestines. The opening first made should be small, and the escape of the cerebrospinal fluid, which may prove a veritable flood, should not be allowed to take place too rapidly. No alarm need be felt at the quantity of this fluid evacuated, since, so far as I am aware, no evil results have been known to follow the plan usually adopted, of letting it run until it stops of its own accord. In an operation on the cervical region, Woolsey (*New York Medical News*, 1904, ii, 625) packed the subdural space at the upper end of the wound with gauze, to check the flow of cerebrospinal fluid before the operation was proceeded with; and he mentions the plan adopted by Schede of encircling the cord above and below the seat of operation with an extradural temporary ligature; but most surgeons have not been forced to adopt such measures to check the ooze.

The opening in the dura is then to be enlarged with scissors to the full extent of the laminectomy wound, and the search for the tumor continued. Almost invariably the tumor, whether intra- or extradural, is found to one side or other of the cord, and nearer its posterior than its anterior surface; but if it is not detected in these situations, the anterior surface of the cord may be cautiously explored with an aneurism needle.

If a cyst is found it should be punctured, and, especially in the case of hydatid cysts (which in all the cases here recorded were extradural), great care should be taken to prevent spread of infection. As a rule, the intradural tumors are found to be more or less encapsulated, and may be removed with only trifling hæmorrhage.

If no tumor can be found in the region of the spinal cord

exposed, the surgeon should not hesitate to remove the spines and laminæ of three, four, or five of the vertebræ higher up. The chances of an error in diagnosis having been made are much less than those of failing to find the tumor through timidity of exploration. Of course, in these, as in all other cases, the extent of the operation must be governed largely by the condition of the patient; and in case of collapse of the patient the operation should be temporarily abandoned, and concluded after a day or two, if possible, when reaction has occurred, as was done in one case by McCosh, with the result that the tumor was found and removed at a higher level than that exposed at the first operation. Where no cause for the symptoms can be found, it is at least possible to divide the posterior roots of the affected nerves, and thus promote euthanasia.

If the dura has been opened, it should be sutured, if at all, very loosely. These patients have done much better when the drainage of cerebrospinal fluid after the operation has been free. Fine catgut is better than silk for the dura, as it is less liable to cause a persistent sinus. Drainage with gauze down to the dura should, I think, be employed in every case. The wound of the soft parts is extensive, and the traumatism will have been considerable; unless free exit is given to the wound discharges suppuration is quite apt to ensue. The gauze may be removed on the fourth or fifth day, or as soon as the patient is able to bear the necessary disturbance. The spinal aponeurosis should be brought together with buried sutures of chromicized catgut, and the skin should be approximated with interrupted sutures of silkworm gut, but not too closely applied.

After the operation no rapid improvement in the patient's condition need be anticipated; indeed, the paralysis and the anæsthesia are sometimes markedly aggravated by the interference with the spinal nerves. But the pain is nearly always remarkably relieved; and the patient is in a more hopeful frame of mind than before the operation.

The after-treatment should be the same as in every serious operation. Calomel and Dover's powder, as in head injuries,

will be beneficial to obviate the tendency to restlessness and wakefulness. The period of rest in bed must vary somewhat with the strength of the patient and with the extent of the operation. Some patients can be allowed to get out of bed in less than a week; but, as a rule, they should maintain the recumbent position for from three to five weeks. When the patient first gets out of bed, his back should be supported in a spinal brace or a plaster cast; and for the partial paralysis of his limbs, which sometimes persists, such orthopædic appliances should be ordered as may be required.

#### LIST OF CASES ANALYZED.

- Abbe. *Journal of Nervous and Mental Diseases*, 1903, xxx, 103. Variety of growth not stated; recovered.
- Abbe. *Thorburn, Brit. Med. Jour.*, 1894, i, 1403. Syringomyelia; no improvement.
- Abbe. *Starr, N. Y. Med. Record*, 1890, ii, 85, Case 6. Sarcoma; died.
- Abrahamson. *Journal of Nervous and Mental Diseases*, 1903, xxx, 102. Not stated; died.
- Anderson. *Ransom, Brit. Med. Jour.*, 1891, ii, 1144. Echinococcus; died.
- Barclay. *Clark, Brain*, 1895, xviii, 256. Endothelioma; died.
- Bottomley. *Munro, Jour. Amer. Med. Assoc.*, 1904, ii, 1183, Case 8. Adhesions; improved.
- Bruns and Kredel. *Archiv f. Psychiat.*, 1896, xxviii, 97, Case 1. *Neurolog. Centralbl.*, 1894, xiii, 281. Sarcoma; died.
- Bruns and Lindemann. *Archiv f. Psychiat.*, loc. cit., S. 133, Case 2. *Neurolog. Centralbl.*, loc. cit., S. 389. Sarcoma; died.
- Caselli. *Riforma Med.*, 1893, iv, 380. Osteoma; recovered.
- Chipault. *Dejerine and Spiller, Comptes Rendus de la Soc. de Biol.*, Paris, 1895, 10<sup>e</sup> Série, ii, 622. Sarcoma; died.
- Crofts. *Horsley, Clin. Jour.*, London, 1896-97, ix, 183. Syringomyelia; improved.
- Curtis. *N. Y. Med. Record*, 1898, i, 346. Secondary carcinoma; died.
- Cushing. *ANNALS OF SURGERY*, 1904, i, 934. Fibrosarcoma; recovered.
- Davies-Colley. *Trans. Clin. Soc. of London*, 1892, xxv, 163. Sarcoma; recovered.
- Davis, George G. *Jour. Amer. Med. Assoc.*, 1904, i, 751. Sarcoma; no improvement.
- Deaver, J. B. *Lloyd, J. H., Amer. Jour. Med. Sc.*, vol. xcvi, p. 564. Adhesions; died.
- Elliot. *Putnam, J. J., Amer. Jour. Med. Sc.*, 1899, vol. cxxviii, p. 385, Case 3. *Journal of Nervous and Mental Diseases*, 1903, xxx, 665, Case 1. Sarcoma; great improvement.
- Elliot. *Putnam, J. J., Journal of Nervous and Mental Diseases*, loc. cit., Case 2. Carcinoma; died.



- Elliot. Putnam, J. J. *Journal of Nervous and Mental Diseases*, loc. cit., Case 3. Fibrosarcoma; died.
- Eskridge and Freeman. *Phila. Med. Jour.*, 1898, ii, 1236. Fibroma; recovered.
- Eskridge and Rogers. *Ibid.*, 1898, i, 332. Tumor of vertebræ; died.
- Faure. Hirtz and Delamere, *Bull. de la Soc. Méd. des Hôp.*, Paris, 1902, xix, 308. Endothelioma; died.
- Fenger. Church and Eisendrath, *Amer. Jour. Med. Sc.*, 1892, vol. ciii, p. 395, Case 6. Spindle-celled sarcoma; died.
- Fripp. White, *Hale, Trans. Clin. Soc. of London*, 1900, xxxiii, 140. Dermoid cyst; died.
- Gerster. *N. Y. Med. Record*, 1890, ii, 131. Putnam and Warren, *Amer. Jour. Med. Sc.*, 1899, vol. cxviii, p. 388, Case 9. Sarcoma; died.
- Gerster. Sachs, *N. Y. Med. Record*, 1900, i, 7, Case 2. Fibrosarcoma; improved.
- Graff. Schultze, *Mittheil. a. d. Grenzgeb. d. Med. u. Chir.*, 1903, xii, 153, Case 7. Fibroma; much improved.
- Graff. *Ibid.*, loc. cit., Case 9. Fibromata; died.
- Hahn. *Deutsch. Zeit. f. Chir.*, 1902, lxxiii, 421, Case 1. *Centralbl. f. Chir.*, 1902, xxix, 399, Case 1. *Berlin. klin. Woch.*, 1902, xxxix, 645, Case 1. Echinococcus; died.
- Hahn. *Deutsch. Zeit. f. Chir.*, loc. cit., Case 2. *Centralbl. f. Chir.*, loc. cit., Case 2. *Berlin. klin. Woch.*, loc. cit., Case 2. Echinococcus; recovered.
- Hahn. *Berlin. klin. Woch.*, loc. cit., Case 3. Osteoma; recovered.
- Hahn. *Deutsch. Zeit. f. Chir.*, loc. cit., Case 5. *Berlin. klin. Woch.*, loc. cit., Case 4. Syringomyelia; died.
- Hartley. Fraenkel, *Journal of Nervous and Mental Diseases*, 1903, xxx, 101. Fibrosarcoma; died.
- Horsley. Gowers, *Trans. Med.-Chir. Soc. London*, 1888, lxxi, 377. Fibromyxoma; recovered.
- Horsley. *Brit. Med. Jour.*, 1890, ii, 1289. Table v. Not stated; died.
- Horsley. *Clin. Jour. London*, 1896-97, ix, 182. Echinococcus; recovered.
- Horsley. *Ibid.*, loc. cit., 183. Syringomyelia; improved.
- Ignatoff. Vayenno *Med. J.*, St. Petersburg, Sect. I, vol. clxxxvii, pp. 30-32; quoted by Putnam and Warren; *Amer. Jour. Med. Sc.*, 1899, vol. cxviii, p. 388, Case 13. Chondrosarcoma; improved.
- Israel, J. *Deutsch. med. Woch.*, 1902, xxviii, Ver.-Beil., 369; 1903, xxix, Ver.-Beil., 110. Chondromyxosarcoma; much improved.
- Krause. Säger, *A. Münch. med. Woch.*, 1894, xli, 431. *Berl. klin. Woch.*, 1901, xxxviii, 583, Case 3. Sarcoma; died.
- Krause. Selberg, *Deutsch. med. Woch.*, 1902, xxviii, Ver.-Beil., 368, Case 2. Remak, *Berlin. klin. Woch.* 1902, xxxix, 646. Angiosarcoma; died.
- Krause. *Berlin. klin. Woch.*, 1901, xxxviii, 541, Case 1. Psammoma; recovered.
- Kümmel. *Archiv f. klin. Chir.*, 1895, vol. I, p. 452. Sarcoma; improved.
- Lennander. Henschen, *Upsala Läkaref. Forhandl. N. F.*, Bd. vi, p. 453, abstracted in *Centralbl. f. Chir.*, 1902, xxx, 935. Schultze: *Mittheil. a. d. Grenzgeb. d. Med. u. Chir.*, 1903, xii, 209. Fibrosarcoma; recovered.

# SURGICAL TREATMENT OF INTRASPINAL TUMORS. 541

- Lloyd, S. Amer. Med. and Surg. Bull., N. Y., 1896, x, 659. Echinococcus; recovered.
- Lloyd, S. Collins, Journal of Nervous and Mental Diseases, 1903, xxx, 100, Case 1. Not stated; much improved.
- Macewen. Lancet, 1888, ii, 254. Adhesions; recovered.
- Macewen. Ibid., loc. cit., Case 2. Adhesions; recovered.
- Macewen. Ibid., loc. cit., Case 3. Adhesions; recovered.
- Macewen. Ibid., loc. cit., Case 4. Adhesions; died.
- Macewen. Ibid., loc. cit., Case 5. Adhesions; died.
- Martin. Spiller and Musser, Trans. Coll. Phys., Phila., 1903, xxv, 1. Cyst; recovered.
- McCosh. Starr, Phila. Med. Jour., 1902, i, 288. Jour. Amer. Med. Assoc., 1901, ii, 569, Case 14. Fibroma; died.
- McCosh. Starr, Amer. Jour. Med. Sc., 1895, vol. cix, p. 613, Case 3. Jour. Amer. Med. Assoc., loc. cit., p. 626, Case 2 in Table II. Sarcoma; died.
- McCosh. Amer. Jour. Med. Sc., loc. cit., Case 5. Jour. Amer. Med. Assoc., loc. cit., Case 1 in Table II. Lipomata; died.
- McCosh. Bailey, Journal of Nervous and Mental Diseases, 1903, xxx, 99. Jour. Amer. Med. Assoc., loc. cit., p. 621, Case 11. Sarcoma or granulation tissue; recovered.
- McCosh. Jour. Amer. Med. Assoc., loc. cit., p. 621, Case 12. Sarcoma; improved.
- McCosh. Jour. Amer. Med. Assoc., loc. cit., p. 621, Case 13. Sarcoma; died.
- Mikulicz. Lichtheim, Deutsch. med. Woch., 1891, xvii, 1386. Psammoma; died.
- Mikulicz. Ibid., loc. cit. Psammoma; marked improvement.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12, Case 18. Putnam and Warren, Amer. Jour. Med. Sc., 1899, vol. cxviii, p. 388, Case 19. Sarcoma; died.
- Munro. Jour. Amer. Med. Assoc., 1904, ii, 1183, Case 10. Thomas, J. J., Trans. Amer. Neurolog. Assoc., 1901, xxvii, 182. Myeloma; much improved.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12, Case 17. Sarcoma; died.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12, Case 14. Cavities in cord; died.
- Munro. Jour. Amer. Med. Assoc., 1900, i, 12. Cyst; improved.
- Park. Putnam and Krauss, Amer. Jour. Med. Sc., 1903, vol. cxxx, p. 1. Sarcoma; much improved.
- Pescarolo. Verhandl. d. X. Internat. Med. Congr. (1890), Berlin, 1892, Bd. iv, Abth. ix, S. 9. Fibromyxosarcoma; not improved.
- Quensel and Garten. Neurolog. Centralbl., 1898, xvii, 482. Sarcoma; died.
- Raymond. Jour. de Neurol., Bruxelles, 1903, viii, 203. Sarcoma; died.
- Rehn. Laquer, Neurolog. Centralbl., 1891, x, 193. Lymphangioma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb. d. Med. u. Chir., 1903, xii, 153, Case 2. Deutsch. Zeit. f. Nervenhe., 1900, xvi, 114, Case 1. Verhandl.

- d. Gesellsch. deutscher Naturfor. u. Aerzte, 73 Versamml, zu Hamburg, 1901, ii, 100, Case 1. Fibrosarcoma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 3. Deutsch. Zeit. f. Nervenhe., loc. cit., Case 2. Verhandl. d. Gesellsch. deutsch. Naturfor., u. s. w., loc. cit., Case 2. Fibromyxosarcoma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 5. Verhandl. d. Gesellsch. deutsch. Naturfor., u. s. w., loc. cit., Case 3. Spindle-celled sarcoma; recovered.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 6. Verhandl. d. Gesellsch. deutsch. Naturfor., u. s. w., loc. cit., Case 4. Angiosarcoma myxomatodes; died.
- Schede. Schultze, Mittheil. a. d. Grenzgeb., 1903, loc. cit., Case 8. Adhesions; died.
- Sonnenburg. Verhandl. deutsch. Gesellsch. Chir., 18 Congr., Berlin, 1889, i, 86. Sarcoma; died.
- Sonnenburg. Oppenheim, Berlin. klin. Woch., 1902, xxxix, 21. Centralbl. f. Chir., 1901, xxviii, 1250. Deutsch. med. Woch., 1901, xxvii, Ver.-Beil., 242. Fibromyxoma; died.
- Sonnenburg. Deutsche med. Woch., 1903, xxix, Ver.-Beil., 321. Oppenheim, Berlin. klin. Woch., 1902, xxxix, 905. Fibroma; recovered.
- Szekeres. Pester, Med.-Chir. Presse, 1894, p. 43, quoted by Putnam and Warren, Amer. Jour. Med. Sc., 1899, vol. cxviii, p. 388, Case 32. Echinococcus; recovered.
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- Thorburn. Brit. Med. Jour., 1895, i, 1403. Adhesions; improved.
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- Trendelenburg. Schultze, Mittheil. a. d. Grenzgeb. d. Med. u. Chir., 1903, xii, 153, Case 1. Pfeiffer, Deutsch. Zeit. f. Nervenhe., 1894, v, 62. Thickening; died.
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- Warren. Putnam, Amer. Jour. Med. Sc., 1899, loc. cit., Case 2. Endothelioma; recovered.
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- Wyeth. Sachs, N. Y. Med. Record, 1900, i, 7, Case 1. Alveolar sarcoma; recovered.